



Green Synthesis and Characterization of Polyvinyl Alcohol Embedded Silver Nanoparticles Using Simul (*Bombaxceiba*) Flower Extract

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ABSTRACT

Aim: Plants biomass extract have very important role for the synthesis of different nanoparticles due to its reducing capability, availability and nontoxicity. The present study reports a very easy and green synthesis of poly (vinyl alcohol) stabilized silver nanoparticles using Simul (*Bombaxceiba*) flower extract.

Methodology: The aqueous extract of Simul (*Bombaxceiba*) flower was used for this bio-reduction. When PVA supported aqueous silver ions exposed to aqueous Simul flower extract, silver ions were reduced and result was green synthesis of silver nanoparticles.

Results: The produced silver nanoparticles were characterised by different technique which includes UV-vis spectroscopy and transmission electron microscopy (TEM). The highest peak at 470 nm in UV-visible spectrum due to surface Plasmon resonance confirmed the presence of silver nanoparticles. TEM analysis showed the spherical and irregular particles shape and size ranging from 20 to 100 nm.

Conclusion: This single-pot method for synthesis of silver nanoparticle is eco-friendly and cost effective than other hazardous chemical methods. Different therapeutic use of PVA-supported silver nanoparticles synthesized from Simul flower, otherwise thrown away as ineffective material into environment is note worthy.

Key Words: Simul, Silver nanoparticle, Polyvinyl alcohol, Green synthesis

INTRODUCTION

Now a days, research on metallic nanoparticles (NPs) are an important field in nanotechnology which deals with synthesis and manipulation of particle's size ranging from approximately 1 to 100 nm in size (Ahmed S. et al., 2016; Yehia et al., 2014). Because of their particular size and morphology nanoparticles exhibits novel chemical, biological and physical properties than their parent materials and are found to be interesting candidates for various applications which includes antimicrobial activity, biosensing particularly in biomedical science (Maiti S. et al., 2014; Padalia H. et al., 2015; Ahmad T. et al., 2013; Okafor F. et al., 2013; Abou et al., 2010) However, particle aggregation remarkably deteriorates their properties. Recently different organic polymer like polyvinyl alcohol (PVA), polyacrylic acid, polyarylest-

ers, chitosan, and poly-acrylonitrile can be used to support, stabilize as well as surface modification, distribution of the nanoparticles (Gaddy G. A. et al., 2004; Rifai S. et al., 2006; Valente, J. F. A., et al., 2013; Chandran S., et al., 2016). The functional groups present in polymeric material plays vital role to efficiently immobilize nanoparticles by different factors like Vander Waals force, electrostatic force, hydrogen or covalent bonds (Sagitha P. et al., 2016). Polyvinyl alcohol has easy acceptability being biodegradable, water soluble, inexpensive and low-toxicity to prepare polyvinyl alcohol-nanoparticles (PVA-NPs) hybrid.

Synthesis of PVA-AgNPs is of much interest to the scientific community because of their wide range of applications. There are many physical and chemical methods for the synthesis of PVA-AgNPs. However most of the methods are quite expensive and potentially hazardous to

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the environment which involves use of toxic and perilous chemicals that are responsible for various biological risks (Ahmed S. et al., 2016; Prozorova G. F et al., 2014). So, there is a need to develop high-yield, low cost, non-toxic and environmentally friendly procedures. In such a situation, biological approach appears to be very appropriate. Natural materials like plant (flower, leaf, bark, fruit etc.) extract or plant biomass, microorganisms for the production of silver nanoparticles could be an alternative to chemical and physical methods in an eco-friendly manner (Reddy G. A. K. et al., 2012)

Simul tree (*Bombaxceiba*) is very useful tree and is found throughout the Asia. Simul commonly known as 'cotton tree' because it produces a white fibre like cotton capsule. It is generally tall straight tree, its leaves are deciduous in winter, red coloured flower with 5 petals appear in spring season. Different parts of this tree have medicinal properties. In Ayurveda it is referred as aphrodisiac, astringent, antidiarrheal, antidysenteric, antimicrobial diuretic, alterative, antipyretic and tonic. It is used in treatment of asthma, diarrhoea, wound, leucorrhoea, anaemia, seminal disorders and skin problems (Asolkar L. V. et al., 1992). A large number of phytochemicals have been found from Simul flower that include glycosides carbohydrate, protein, flavonoids, etc. Here the advantages for synthesis of PVA-AgNPs using *Bombaxceiba* flower is that their easy availability, non-toxicity and presence of a broad variability of biomolecules which may aid in reduction process (Joshi K. R. et. al., 2013)

This article reports the simple green method for synthesis of polyvinyl alcohol supported silver nanoparticles (PVA-AgNPs) using flower extract of *Bombaxceiba*. According to my knowledge this is the first report for the synthesis of PVA-AgNPs hybrid using Simul flower extract.

MATERIALS AND METHODS

Preparation of flower extract

Fresh flowers of *Bombaxceiba* growing in road side of Bankura district, West Bengal, India, were collected (Figure 1). Fresh flowers were washed extensively with water followed by final wash with double distilled water. Washed flower were dried in sunlight and after grinding 5 g of flower powder was mixed with 100 ml double distilled water in 250 ml Borosil beaker and heated for 60 minutes. Then the extract was filtered through Whatman filter paper (pore size $>0.5\mu\text{m}$), collected and stored in refrigerator (4°C) to use within 1 week.

Preparation of metal solution

Initially 1M AgNO_3 solution was prepared (4.25 g silver nitrate was dissolved in 25 ml double distilled water). From it 0.25 M AgNO_3 solution was prepared.



Figure 1: Bombaxceiba flower.

Synthesis of nanoparticles (AgNPs)

The aqueous Simul flower extract had been used for the bio-reduction process. At first 0.5 ml of the flower extract was mixed with 10% 0.5 ml PVA solution and then 3 ml of 0.25M AgNO_3 solution was mixed and kept at room temperature for 1 hour. Colour of the solution was changed from very light yellow to dark brownish indicating the formation of silver nanoparticles.

Characterization of SNPs by UV-vis spectroscopy and TEM

Synthesis of AgNPs was monitored using a Shimadzu (UV-1800) double-beam spectrophotometer. The absorption spectrum in the range of 400 to 700 nm of the reaction medium after diluting a small aliquot of sample and crude water extract. TEM (Transmission electron microscopy) analysis was done to visualize the shapes well as to measure the diameter of the bio-synthesized silver nanoparticles. Nanoparticles were screened in high resolution JEOL JEM1400 plus microscope operating at an accelerated voltage of 120 kV.

RESULTS

Characterization of nanoparticles by Colour change, UV-Visible spectra and TEM

Upon addition of flower extract to the solution of PVA- AgNO_3 , the colour appeared as dark brown within 1 h of incubation at room temperature (Figure 2) indicating the formation of nanosilver. The formation of AgNPs occurs from few minutes to hour and corresponding UV-Visible absorption spectra of AgNPs were recorded which shown in Figure 3. The shape and size distribution of the synthesized AgNPs were characterized by TEM study (Figure 4).

DISCUSSION

The bio-reduction of PVA supported silver ions to PVA-AgNPs using Simul flower extract was understood visually by

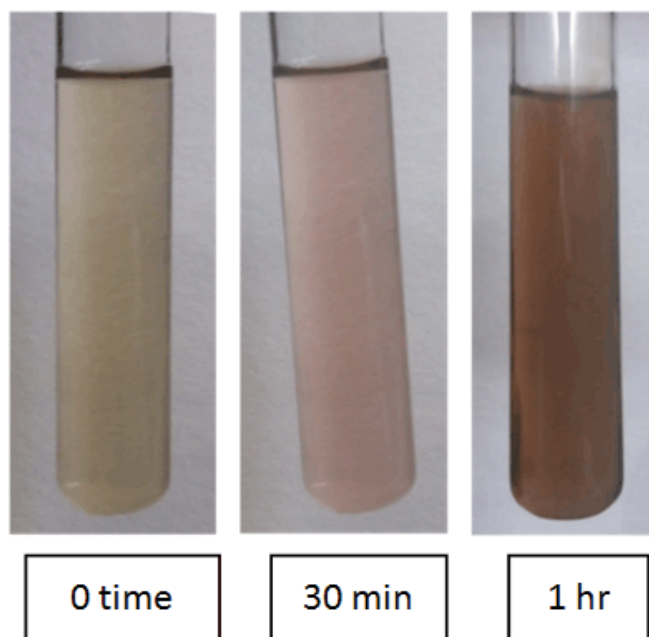


Figure 2: Increase in the colour intensity of the reaction mixture with time for 0 time, 30 min and 1 hr.

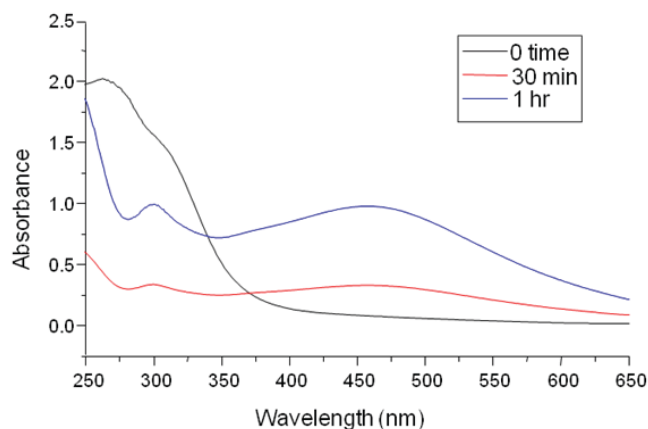


Figure 3: UV-vis absorption spectra of PVA supported silver nanoparticles at different time intervals.

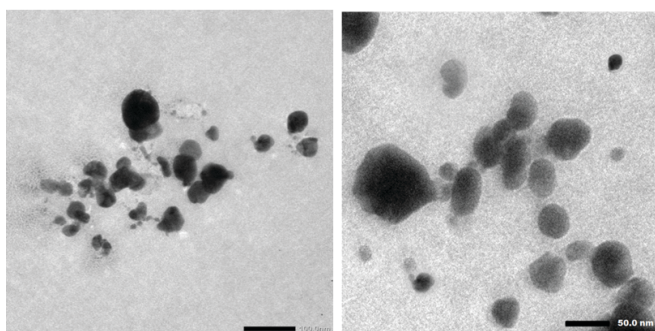


Figure 4: TEM image of PVA embedded silver nanoparticles.

colour change of the reaction mixture from very light yellow to dark brown (Figure 2). The intensity of colour increases with increase in time which indicates the reduction of more silver ions and more silver nanoparticles formed.

The characteristic dark brown colour of silver provided a convenient spectroscopic signature to indicate nanoparticles formation. The formation of silver nanoparticles can be detected by UV-Visible spectroscopy by analyzing its characteristic surface plasmon resonance band (SPR) due to the combined vibration of electrons of metal nanoparticles in resonance with the light wave (Rajkumar G. et al., 2012). The maximum absorbance peak at 470 nm in the UV-absorption spectrum, confirmed the presence of surface plasmon resonance peak of silver nanoparticles (Figure 3). The intensity of the absorption peak increases steadily with time indicates that the intensity of colour was directly proportional to the amount of AgNPs produced and the results corresponds to the earlier studies which reports green synthesis of silver nanoparticles showing absorption band 420-480nm (Rajana R. et al., 2015)

The polymer supported nanoparticles are imaged using transmission electron microscopy (Figure 4) to further confirm the generation of SPR band in the UV-visible spectrum for AgNPs. The photograph of TEM shows formation of non-agglomerated silver nanoparticles with spherical and irregular particles shape and size ranging from 20 to 100 nm.

CONCLUSION

Using Simul flower extract a simple, low-cost, eco-friendly one-pot synthesis was carried out to prepare Polyvinyl supported silver nanoparticles at room temperature. Biosynthesized PVA-AgNPs was characterized from the characteristic surface plasmon resonance peak obtained from the UV-Visible spectroscopic studies. Morphology studies were done using transmission electron microscope. This synthesis method and reaction conditions lead to the formation of silver nanoparticles of 20-100 nm in size with spherical and irregular particles shape. The synthesized PVA-silver nanoparticle hybrid can show new pathways in various fields like bio-sensing, antibacterial, water purification, antifungal, anticancer activity and specially drug delivery systems.

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Conflict of Interest

The author has declared that no conflict of interest exists.

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